



A bibliometric review of flipped classroom approaches for enhanced students' language learning

Liu Dan ^{1*}

 0009-0007-3685-236X

Hasnah Binti Mohamed ¹

 0000-0001-5119-6742

¹ University of Technology Malaysia, Johor Bahru, MALAYSIA

* Corresponding author: liudan@graduate.utm.my

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ABSTRACT

The widespread use of contemporary flipped classrooms for teaching, especially in language learning, provides new insights. Flipped classrooms are two important aspects of language learning that produce impactful outcomes and understanding. It is essential that these processes be used to strengthen the system of language learning. We used PRISMA statement templates for bibliometric analysis. The analysis is based on publications from 2014 to 2023. We examined and analyzed 309 databases from Scopus to gain insights into flipped classrooms and language learning. Concurrently, distinct inclusion and exclusion standards were applied for the screening process. Through a bibliometric analysis, we have determined the distribution of publications on the impact of flipped classrooms on language learning between 2014 and 2023. Additionally, we have identified the most significant journals and authors, the prominent countries engaged, the primary research keywords, and the key subject areas explored. This study illustrates trends and suggestions for flipped classroom and language learning. Suggestions are also made to improve students' academic performance by making full use of the effects of flipped classroom on language learning.

Keywords: flipped classroom, flipped learning, language learning, bibliometric analysis

INTRODUCTION

In language teaching, more and more teachers have adopted the flipped classroom, which enables students to complete part of the teaching content after class and enhances teaching activities in class, which is different from traditional teaching methods. Global studies have shown that flipped learning has an impact on language teaching in terms of improving English learners' performance, motivation and participation (Kantamas, 2023), and that middle school students also have positive changes in learning attitudes and cognition during the process of language learning (Li, 2022). This method enables students to learn in a personalized and flexible way, and provides students with convenient learning opportunities (Kantamas, 2023). From the perspective of different countries: the implementation of the two countries in different contexts, from Thailand to Turkey, shows that both teachers and learners actively use flipped classroom and make it promote active learning and improve language interaction skills in the classroom (Kostas, 2017).

According to Goksu and Duran (2020), the flipped model changes the traditional teaching method, transferring the direct teaching content outside the classroom, and students participate in more classroom activities in the classroom. The flipped classroom uses Bloom's taxonomy to shift knowledge acquisition and comprehension from outside the classroom – such as memorization and comprehension – to inside the classroom (SivaKumar, 2023). Allowing more classroom time for higher-level learning activities, like application, analysis, evaluation, and creation. Compared with traditional teaching, this approach enables

students to participate more actively in learning both inside and outside the classroom, thus enhancing learning outcomes and constituting a more innovative and participatory teaching model.

The flipped classroom represents a revolution in language instruction, and the opportunity for this change necessitates careful planning and responsiveness to technical problems. Especially in the context of language training, covering a wide range of topics. At the heart of the flipped classroom concept is the emphasis on student-center class, with standard classroom teaching and homework elements turned upside down (Hung, 2015). The adoption of the flipped classroom includes a variety of instructional practices that leverage modern information technology to enhance learning outside of the typical classroom environment (Chen Hsieh et al., 2017). However, the flipped classroom faces some obstacles, such as the necessity for extensive preparation before class, which may raise instructors' workloads (Lo & Hew, 2017). The flipped model is aligned with active learning methodology and can be tailored to specific student needs, making it a valuable tool in the rapidly changing area of education (Howell, 2021).

The effectiveness of flipped classroom method in improving students' language learning is constantly increasing (Vitta & Al-Hoorie, 2023). Through bibliometric analysis, we can systematically sort out and quantify research results in this field, identify research hotspots, trends and key contributors, and provide clear direction and reference for subsequent research. In addition, through a statistical analysis of a large number of literatures, the application effect and evolution path of flipped classroom in language learning are revealed, which helps scholars to more comprehensively understand the actual impact of this teaching method and its potential improvement space. By summarizing the main findings and contributions of this study, the potential impact and significance of this review on the flipped classroom field and language learning teaching are presented.

Purpose of the Review

The goal of this research is to investigate trends and recommendations in flipped classrooms and language learning, using bibliometric analysis approaches to examine publications. This study also seeks to show current patterns in the examination of flipped classrooms and language acquisition across a range of topics. The data for this study was collected from the Scopus database and addresses the following research questions:

1. How has the distribution of publications related to flipped classrooms and language learning evolved between 2014 and 2023, and which journals and authors have been the most influential in this field?
2. Which countries have played a leading role in contributing to research on flipped classrooms and language learning, and what key research keywords have emerged over the past decade?
3. Which subject area most prominently features research on flipped classrooms and language learning?

MATERIALS AND METHODS

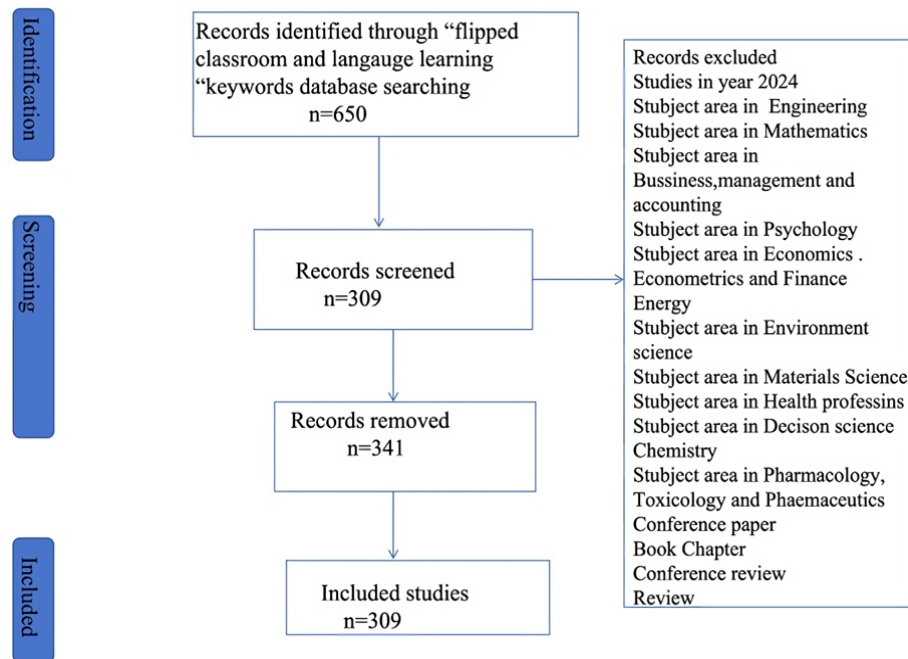
The study used bibliometric and meta-analysis approaches to conduct a systematic literature review (Tripathy et al., 2024). This study's research methods and procedures followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement template. By following the PRISMA template's thorough reporting standards, readers can judge the methodological rigor and accuracy of research conclusions (Paul & Barari, 2022).

The PRISMA template consists of four steps: identification, screening, eligibility, and inclusion (Page et al., 2021). During the identification step, databases were searched systematically using carefully selected keywords to find relevant papers on flipped classrooms and language acquisition. Duplicates and irrelevant research were removed throughout the screening process to help refine the list. Finally, during the inclusion phase, papers that fulfill all criteria were included in the systematic review and meta-analysis, laying the groundwork for detailed analysis and synthesis (Page et al., 2021). **Table 1** would show the inclusion and exclusion criteria based on the research.

The theme selected for this literature review is the flipped classroom and language learning. The Scopus database was utilized for the retrieval of relevant studies. According to **Figure 1**, data selection was performed using the PRISMA statement template. In the identification phase, the first step involved using the keywords

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion Criteria
Research on flipped classroom and language learning	Research outside the specified subject areas
Publications from the year 2014 to 2023	Publication prior to 2014 and those from 2024
Articles published in English	Publication in other language
Journal articles	Conference paper, book chapter, conference review, review
Journal as the source type	All other sources

**Figure 1.** The systematic literature review process (Source: Authors)

"flipped classroom" and "language learning" to identify records within the database. According to prevalent themes in systematic review, student autonomy and motivation, the use of technology, active learning, e-learning, and student perception are several frequent topics. Flipped classrooms emphasize active learning for students, requiring them to preview content before class and actively participate in discussions during class. The application of technology makes the learning process more flexible and personalized (Bicen & Beheshti, 2022). In addition, students' perception and feedback on this teaching mode is also an important aspect of the research, and their perception directly affects the effectiveness and continuous improvement of flipped classroom (Lee & Wallace, 2018; Webb & Doman, 2020). These topics together constitute the core elements of flipped classroom in language teaching and have a profound impact on teaching outcomes.

This systematic review included a total of 309 research publications. The search process is TITLE-ABS-KEY (flipped AND classroom AND language AND learning) AND PUBYEAR > 2013 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "SOC") OR LIMIT-TO (SUBJAREA, "ARTS") OR LIMIT-TO (SUBJAREA, "COMP")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")). This process excluded studies published in 2024 and certain unrelated academic fields such as healthcare, business, and engineering. Reviews, editorial texts, and conference papers were not included in the analysis. These documents were then subjected to data analysis and visualization using the VOSviewer software tool. VOSviewer is capable of effectively analyzing and visualizing bibliometric data, making it suitable for this study (Martins et al., 2022).

RESULT

The first research question is to analyze the distribution of publications on flipped classrooms and language learning between 2014 and 2023. As shown in **Figure 2**, the number of files produced during this decade has increased. The number of publications in 2014 and 2015 was still the same number, but increased

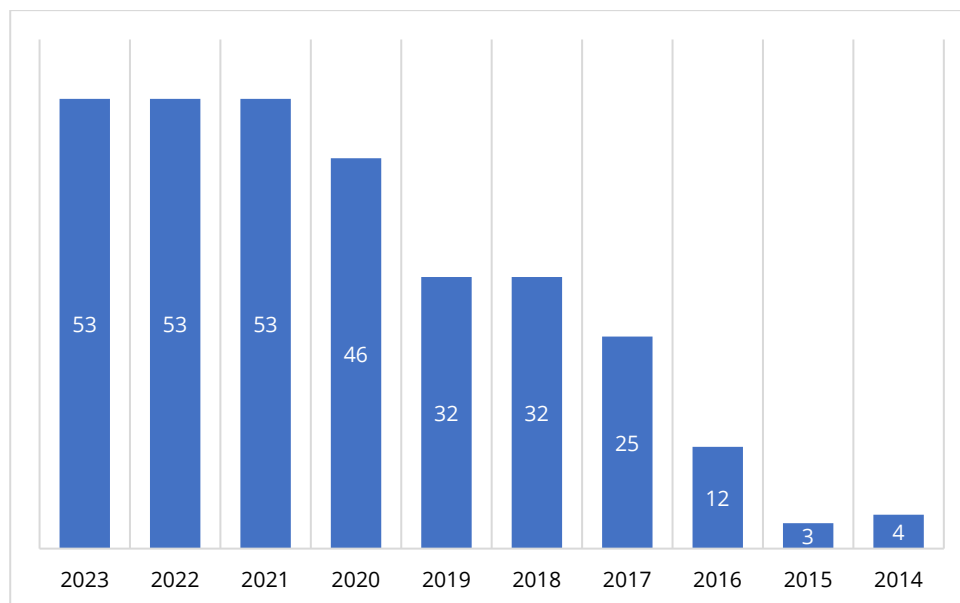


Figure 2. Distributions by years (Source: Authors)

Table 2. Top-10 most productive journals in flipped classroom and language learning research

No Journals	TP	TC	CS	Most cited articles	TIC
1 Computer Assisted Language Learning	15	2,813	12.6	Flipping the classroom for English language learners to foster active learning	439
2 Turkish Online Journal of Distance Education	10	828	3.3	The implementation of a flipped classroom in foreign language teaching	119
3 Interactive Learning Environments	9	4,054	11	Clickers in the flipped classroom: Bring your own device (BYOD) to promote student learning	102
4 Education and Information Technologies	8	10,614	8.2	An account of EFL learners' self-efficacy and gender in the flipped classroom model	88
5 International Journal of Emerging Technologies in Learning	6	8,389	5.0	Flipping the classroom for English language learners: A study of learning performance and perceptions	46
6 International Journal of Learning, Teaching and Educational Research	6	1,568	1.7	Teachers' viewpoint of metacognitive strategy instruction in listening during remote teaching in Oman: Challenges and strategies	6
7 Journal of Asia TEFL	6	650	1.7	Flipping a Chinese university EFL course: What students and teachers think of the model	34
8 Educational Technology and Society	5	968	5.8	Creating an online learning community in a flipped classroom to enhance EFL learners' oral proficiency	140
9 Teaching English with Technology	3	330	3.2	Individual or collaborative WhatsApp learning? A flipped classroom model of EFL writing instruction	23
10 Theory and Practice in Language Studies	5	547	0.6	Flipped classroom as a supporting plan for Iranian EFL learners' English improvement in super intensive courses	3

Note. CS: Cite scores (2022) & TIC: Times cited

to 12 in 2016, and the growth has been relatively rapid since 2017. The number increased to 32 from 2017 to 2019, and to 53 in 2023. It will remain at 53 from 2021 to 2023.

In terms of identifying the most relevant journals and authors in flipped classrooms and language acquisition. Table 2 presents an analysis and summary of the most significant journals in flipped classroom and language learning. The Scopus database was searched for the top-10 most frequently cited journals on the subject. The journal's details are presented, including the top-publication (TP), total citation (TC), citation score, most cited articles, and time of citation. Table 2 shows that Computer Assisted Language Learning, the publication with the greatest research on flipped classrooms and language learning, has published 15 papers and been cited 2,813 times. The most cited article in this journal is flipping the classroom for English language

Table 3. Top-10 most authors in flipped classroom and student learning research

No	Name	TP	TC	h	Most cited article	TIC	Affiliation
1	Hung, Hsiu-Ting	30	1,509	13	Flipping the classroom for English language learners to foster active learning	439	National Kaohsiung University of Science and Technology
2	Doman, Evelyn	4	129	3	Impacts of flipped classrooms on learner attitudes towards technology-enhanced language learning	62	Unibetsedat Guahan
3	Izadpanah, Siros	44	157	6	The effect of the flipped classroom model on Iranian English foreign language learners: Engagement and motivation in English language grammar	23	Islamic Azad University, Zanzan Branch
4	Lin, Chijen	20	629	12	A learning analytics approach to investigating factors affecting EFL students' oral performance in a flipped classroom	114	Chung Shan Medical University
5	Roohani, Ali	27	127	8	Flipping EFL learners' writing classroom through role-reversal and discussion-oriented models	8	Shahrekord University
6	Zou, Di	165	3,238	31	Flipping an English writing class with technology-enhanced just-in-time teaching and peer instruction	68	Lingnan University, Hong Kong
7	Angelini, María Laura	11	55	5	Integration of the pedagogical models "simulation" and "flipped classroom" in teacher instruction	12	Universidad Católica de Valencia San Vicente Mártir
8	Chen, Ching-Huei	54	1,582	22	Which students benefit most from a flipped classroom approach to language learning?	132	National Sun Yat-Sen University
9	Hafidi, Mohamed	42	169	7	Implementing flipped classroom that used a context aware mobile learning system into learning process	7	Université Badji Mokhtar-Annaba
10	Rad, Hanieh Shafiee	14	84	5	Flipping EFL learners' writing classroom through role-reversal and discussion-oriented models	8	Hanieh Shahrekord University

Note. h: h-index & TIC: Times cited

learners to foster active learning, which has been cited 439 times. Next came the Journal Turkish Online Journal of Distance Education, which published 10 articles and was used 823 times. But Education and Information Technologies had the highest TC, at 10,614.

Research question 1 also analyzes the authors who are most effective in flipped classrooms and language learning. The Scopus database was searched to locate the top-10 authors. The analysis of flipped classroom and language learning is shown in **Table 2**, including the author's name, the number of published articles, top-citation, h-Index, the most cited articles and the unit to which they belong.

Table 3 summarizes and lists the top-10 authors who have been most effective in the area of flipped classrooms and language learning. According to the Scopus database, the number one author in this field is Hsiu-Ting Hung from the National Kaohsiung University of Science and Technology, who has published a total of 30 papers, It has been cited 1,509 times and has an h-index of 13. Among them, Di Zou from Lingnan University and Hong Kong published the largest number of articles, with 165 articles and 3,282 times of citation, which is the highest among them. The h-index is 31 and ranks first.

The second question looks at the countries that have contributed the most to flipped classroom and language learning research. **Figure 3** displays a map of the most significant countries regarding of TP based on Scopus database analyses. **Table 4** summarizes and lists some of the analytical criteria for the most important countries for flipped classrooms and language learning: including ranking, country, TP, and most important academic institutions.

The United States is the most important country in the field of flipped classrooms and language learning, as can be seen from **Figure 3**. In **Table 4**, a total of 34 papers have been published, and Towson University is the leading research institution in this sector. It is followed by China and Iran, both with 31 published papers, with the University of Hong Kong and Shahrekord University as their most important institutions. Turkey has published 28, and Aksaray University is the country's most important institution in this field. **Table 4** lists the countries that publish the most in this area and the institutions in their countries that publish the most in this area.

The Most Significant Countries in flipped classroom and language learning

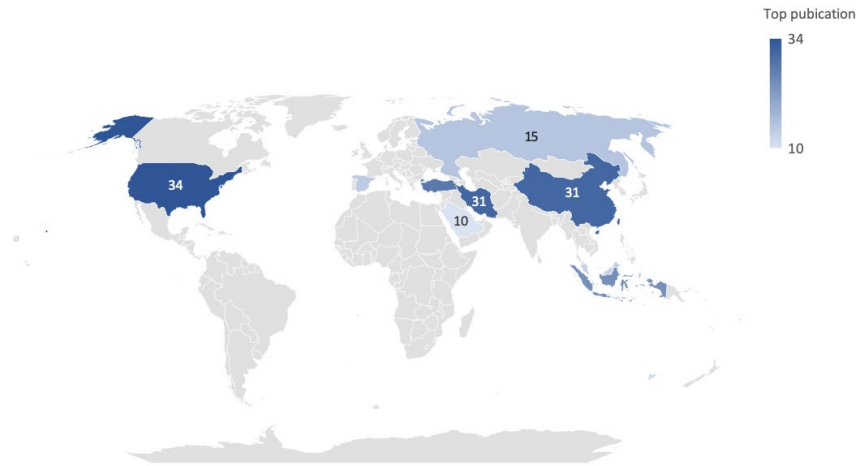


Figure 3. The geographical chart of the most major countries in flipped classroom and language learning (Source: Authors)

Table 4. An overview of the most important countries in flipped classroom & language learning research area

No	Country	TP	Most significant academic institution
1	United States	34	Towson University
2	China	31	Chinese University of Hong Kong
3	Iran	31	Shahrekord University
4	Turkey	28	Aksaray University
5	Indonesia	24	Universitas Negeri Malang
6	Russian Federation	15	Tomsk Polytechnic University
7	Spain	14	Universidad Católica de Valencia San Vicente Mártir
8	Malaysia	13	Universiti Kebangsaan Malaysia
9	Australia	11	Monash University
10	Saudi Arabia	10	Najran University

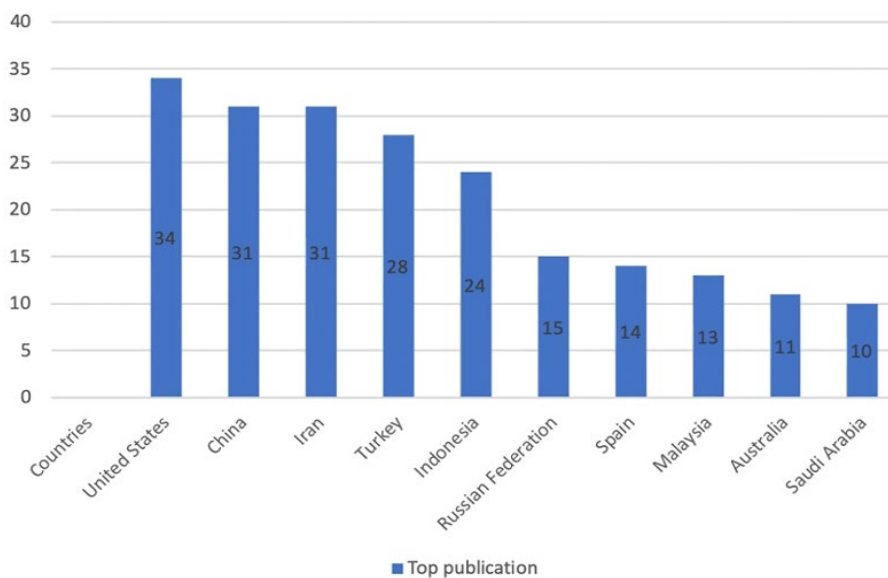


Figure 4. The bar chart displaying the quantity of publications (Source: Authors)

Figure 4 uses a clear bar chart to plot the number of publications for each country. The United States has the largest number of documents, followed by China, Iran, and Turkey.

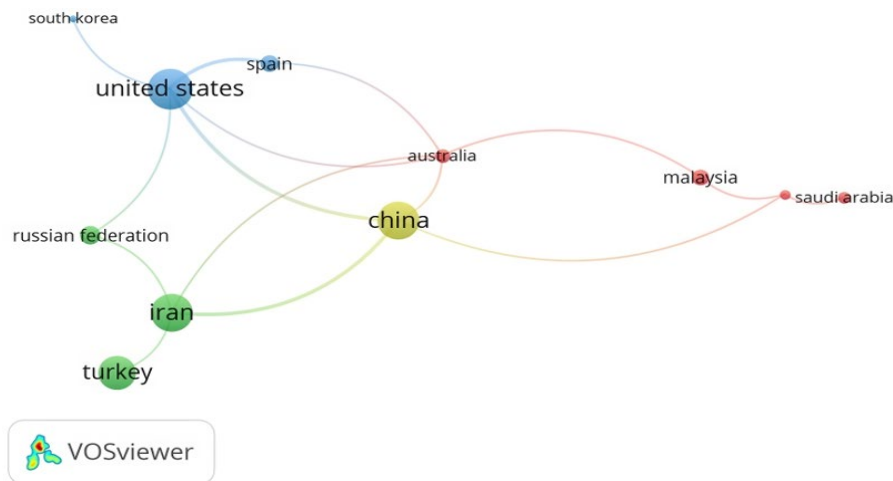


Figure 5. An illustration of the co-authorship relationships with countries (Source: Authors)

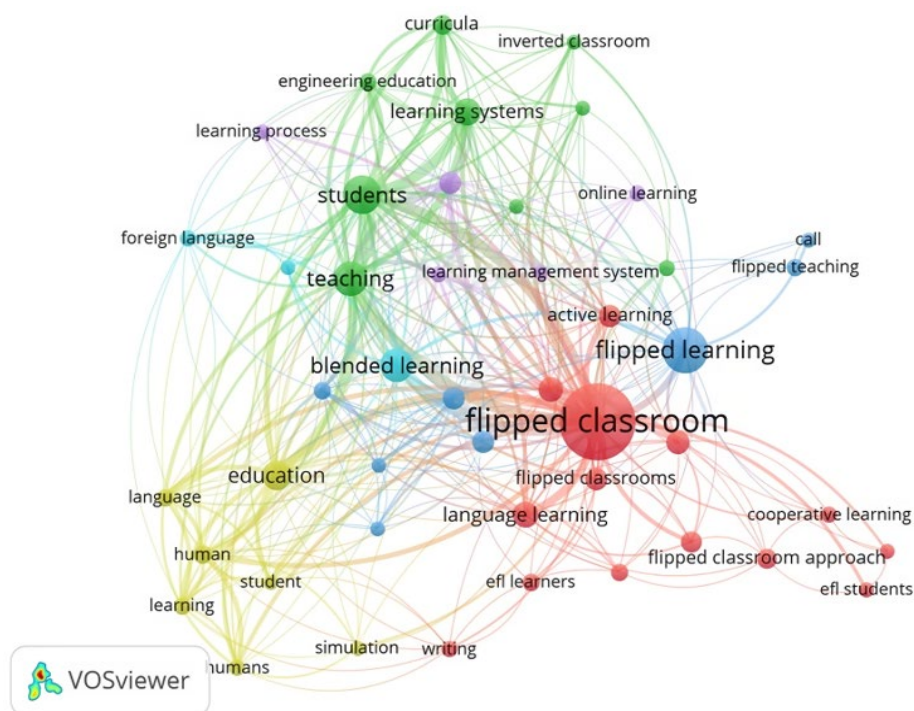


Figure 6. A map based on the relationship of co-occurrence with all keywords (Source: Authors)

The association between co-authors and countries connected to flipped classroom and language learning research was examined in this study using the VOSviewer program. The highest coauthor-country link strength was in China and the United States, with nine links. Among them, 31 published literatures and 360 citations were involved in China, while 33 citations and 854 citations were involved in the United States. Iran's link strength was 4, 31 published literatures and 578 citations. Turkey has 841 citations and 28 publications, but the link strength is 1. The chart also shows the links between co-authors in other countries.

The co-authorship connection with countries is depicted in [Figure 5](#). The lines connecting each country indicate the collaborative relationships between researchers from different nations, as evidenced by co-authorship of academic papers. The number of publications coming from each country is shown by the size of the circles, with larger circles denoting a higher number of publications. This visual representation allows for an easy assessment of both the collaborative networks and the research output of each country in the context of the studied field.

The second question also examines the use of key research keywords in analytical studies on flipped classroom and language learning from 2014 to 2023. This study examines the co-occurrence of all keywords

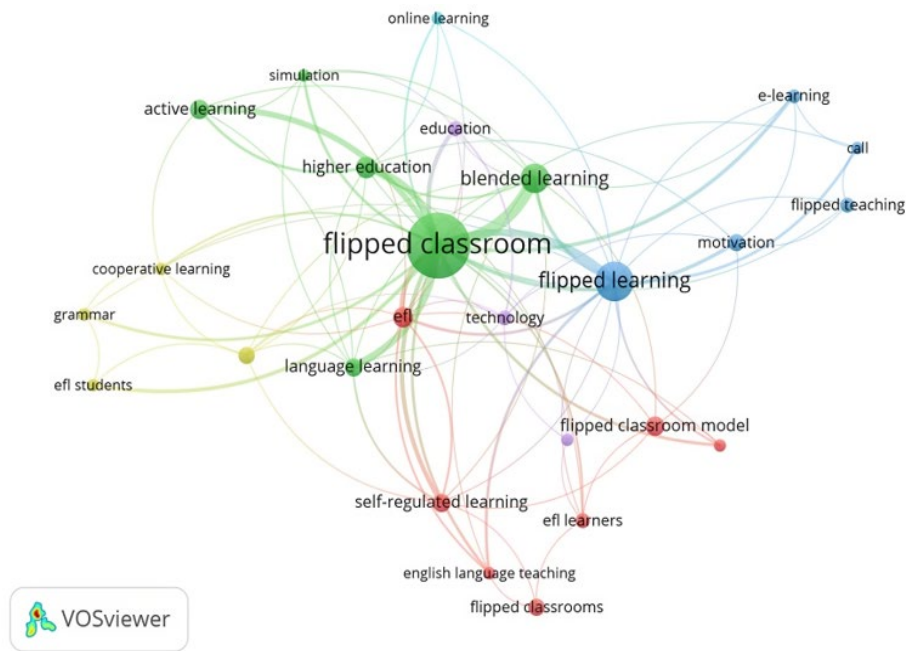


Figure 7. A map based on the relationship of co-occurrence with author keywords (Source: Authors)

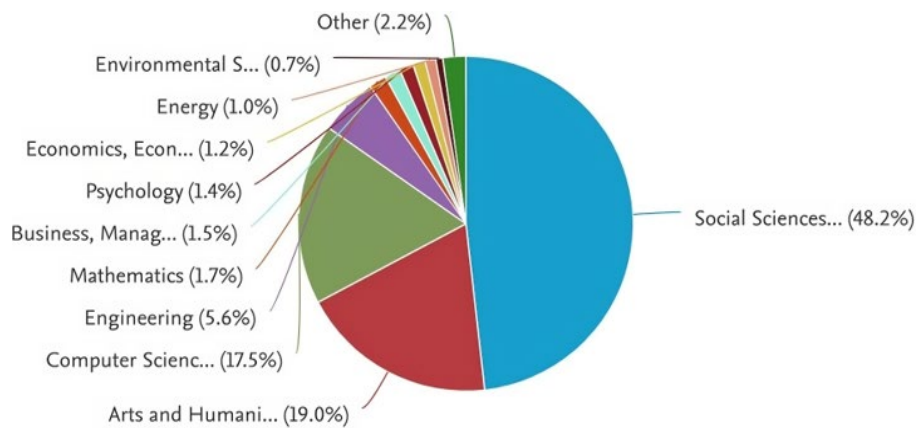


Figure 8. The pie chart illustrates the distribution of publications across various subject areas (Source: Authors)

in data related to flipped classroom and language learning. **Figure 6** shows the mapping based on the co-occurrence relationships of all keywords in Scopus data. The keyword with the highest co-sightings was flipped classroom, with an Oc of 141 and the highest link strength, at 217. The flipped degrees were flipped learning (Oc = 49), students (Oc = 34), and teaching (Oc = 29). The link strength of students reached 146, teaching (138), and education (94).

Figure 7 analyzes the co-occurrence of the author’s keywords. Among them, the flipped classroom had the highest number of appearances, with 139 and a link strength of 102. Next came blended learning, with 49 flipped times and 35 link strength. Blended learning had 27 flipped times; the link strength is 33. EFL (Oc = 13), higher education (Oc = 14), language learning (Oc = 11).

According to the third research question, which is to identify the most important subject area for flipped classroom and language learning, the data is analyzed by subject area, as shown in **Figure 8**. Social science had the highest percentage, reaching 48.2% with 284 published articles, and social science was the most important subject area for flipped classroom and language learning. Arts and Humanities is the next most relevant subject area, accounting for 19% and 112. The publication of Computer Science also ranks third, the number is 103, accounting for 17%. At the bottom of the list is environmental science, which accounts for only 0.7%.

DISCUSSION

The above three research questions are answered in turn by analyzing the results of the files from the Scopus database. The distribution of publications on flipped classroom and language learning generally shows an increasing trend from 2014 to 2023. The importance of language learning through flipped classrooms is increasing. The research of Debbag and Yildiz (2021) supports this, pointing out that flipped classroom and language learning can improve students' learning motivation and student achievement. Due to the development of blended teaching, interest in the flipped classroom and language learning has gradually escalated. Turan and Akdag-Cimen (2020) also point out that the application of flipped classroom in language learning is developing rapidly in the education industry. This is strongly supported by the increasing distribution patterns of flipped classrooms and language learning publications over the past decade.

In addition, according to the bibliometric analysis, the journal most relevant to flipped classroom and language learning research is *Computer Assisted Language Learning*, and the most frequently cited article is *Flipping the classroom for English language learners to foster active learning*, Huang (2015) found in the article that flipped curriculum is helpful for students to obtain better learning outcomes, cultivate better learning attitudes, and invest more energy in the learning process. This study also found that the use of flipped classrooms in language learning classrooms can fully realize the potential of personalized learning and improve instruction (Cevikbas & Kaiser, 2022). The most prolific author in this analysis is Hsiu-Ting Hung of the National Kaohsiung University of Science and Technology, whose paper is the most cited, It is mainly discussed that flipped classroom can cultivate English learners' active learning ability (Hung, 2015).

Furthermore, the analysis found that the most important country in the field of flipped classroom and language learning analysis research is the United States, with the largest number of publications, of which Towson University is its most important academic institution. In a study from the United States, a statistically significant change over time in all self-reported attitudes toward using technology for language learning (Webb & Doman, 2020). Another study showed that flipped classrooms are effective in enhancing higher-order thinking processes and fostering in-depth, cohesive discussions in content-based second language learning (Kim et al., 2017). One of the most cited articles from the United States is *Using the flipped classroom to enhance EFL learning*, and the study found that theory-based flipped instruction with online written and oral interaction increased participants' motivation, and significantly improved their idiomatic knowledge, indicating successful achievement (Chen Hsieh et al., 2017).

Policy support not only promotes the implementation of flipped classroom, but also provides necessary resources and conditions for its application in practical teaching (Al-Samarraie et al., 2020). With the support of the policy, educators and scholars can carry out the research of teaching method reform more actively. Through bibliometric analysis, it can be seen that scholars in the United States, China, Iran, and other countries are more motivated to explore the application effect of flipped classroom, optimization strategies and adaptability research in different educational environments. This is inseparable from the improvement of teaching quality and students' comprehensive quality when the national education policy encourages educational innovation and carries out teaching reform (McLaughlin et al., 2016). This combination of policy and teaching practice is helpful to promote the continuous progress and development of education.

This study also analyzes the main research keywords of flipped classroom and language learning from 2014 to 2023. According to the results of flipped classrooms and students, learning is the most frequently used keyword in this research area. The co-occurrence rate of these three keywords is also relatively high with other keywords. Research shows that the flipped classroom model provides students with more self-directed learning opportunities and promotes their active participation and deep understanding in language learning (Jeong, 2022). As the subject of the learning process, students can acquire knowledge outside the classroom through preview and independent exploration, while classroom time is used for problem solving, discussion and strengthening language skills. students are more inclined to cooperative learning and interactive communication in the flipped classroom environment, thus expanding their language application scenarios and communication skills (Yeşilçınar, 2019). Therefore, the flipped classroom model provides an innovative teaching method for language learning, which can effectively promote the development of students' language ability and the cultivation of cross-cultural communication ability.

According to the most important subject areas affecting flipped classrooms and language learning, with social sciences being the most important subject area. Flipped classrooms and language learning are also very important in two subject areas, Arts and Humanities and Computer Science. Flipped classroom model can promote students' in-depth understanding of culture, history, literature and other fields and develop critical thinking skills (Khasawneh, 2023). Through preview and independent study, students can better understand the language and cultural connotations behind artistic works, historical events and literary works, thereby improving their cultural literacy and literary appreciation ability. In the field of Computer Science, flipped classroom enables students to cultivate in-depth understanding and practical ability through online resources outside the classroom (Shen & Chang, 2023).

In conclusion, the importance of studying the trend of flipped classroom and language learning is reflected in several aspects: the research on flipped classroom and language learning trend can help educators and scholars understand the current development trend of this teaching model and subject field, so as to guide the future teaching practice and research direction. By analyzing the practical experience and effect of flipped classroom and language learning, it can provide suggestions for teachers to optimize teaching methods and strategies, so as to improve teaching effect and students' learning performance. It can promote the development of related subject areas, promote the integration of educational technology and language learning theory, and promote educational reform and innovation. It also can expand interdisciplinary research and bring new ideas and methods to the development of disciplines.

CONCLUSION AND IMPLICATION

This study conducted a bibliometric analysis of 309 publications on flipped classroom and language learning. As a whole, from 2014 to 2023, there are more and more publications on flipped classroom and language learning. The importance of these two themes is recognized by researchers. Related journals are mostly published by Computer Assisted Language Learning, making important contributions to flipped classroom and language learning. The most prolific author to date is Hsiu-Ting Hung, from the National Kaohsiung University of Science and Technology. He has published 30 articles in this field and has been cited 1,509 times in total. In addition, the country with the most influence in this field is the United States, with 34 publications, and Towson University is the institution that contributes the most to flipped classroom and language learning research. In terms of co-authors and all keywords, flipped classroom and students, teaching is the most frequent, and most journals are reflected in keywords, abstracts, and text, which are used to analyze the impact of flipped classroom on language learning. In terms of the strength of co-authors' links to countries, the strongest are the United States and China. The co-authorship relationship among countries signifies the global scientific community's interconnectedness and underscores the critical role of international collaboration in advancing knowledge and tackling global challenges. Social sciences, humanities and arts, and computer science are the most important subject areas for flipped classroom and language learning, and each of these fields plays an important role in taking full advantage of flipped classroom and language learning. Other subjects such as engineering, psychology, and mathematics are also involved.

The main conclusion that can be drawn from this study is that flipped classroom has a significant effect on improving students' language learning. Through bibliometric review analysis, we found that flipped classroom can effectively improve students' learning environment, promote independent learning, and improve learners' enthusiasm and participation. This approach not only helps teachers better understand learners' behaviors and needs, but also optimizes teaching strategies to achieve more efficient language learning. Flipped classrooms can support personalized learning, significantly improve students' ability to learn independently, and cultivate their ability to think independently and solve problems. Flipped classroom emphasizes the application of technology in education, and we should continue to explore how to use advanced technology to further enhance the teaching effect in the future. Flipped classroom may adopt more online and offline mixed teaching mode, make full use of online resources and offline interaction, and improve teaching flexibility. In short, flipped classroom brings new opportunities and challenges to language learning, and its future development prospects are broad, worthy of further attention and in-depth research.

Limitation

The limitations of this study are mainly in two aspects:

1. **Single database:** This study mainly relied on Scopus database for bibliometric analysis. Although Scopus is a widely used and informative academic database, its coverage is limited. Other important databases such as Web of Science, Google Scholar and databases in various professional fields are not included, which may lead to the omission of some relevant research literature, affecting the comprehensiveness and representation of research results.
2. **Detail of keyword selection:** This study may not be detailed and comprehensive enough in keyword selection. Since flipped classroom and language learning are multidisciplinary fields of study, relevant keywords should cover more variants and synonyms. In addition, inadequate consideration of differences in expression across regions and languages may lead to the neglect of some specific studies, thus affecting the comprehensiveness and accuracy of the literature collection. Future studies should be more nuanced and diverse in keyword selection to ensure a comprehensive coverage of the relevant literature.

In summary, the limitations of a single database and insufficient detailed keyword selection in this study may affect the comprehensiveness and accuracy of the research results. These limitations suggest that we should make more extensive use of multiple databases in future research and be more detailed and diversified in keyword selection to ensure the comprehensiveness and scientific nature of the research.

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Declaration of interest: The authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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